Claims

I claim:

1. A band-pass filter, comprising:

a stacked pair of film bulk acoustic resonators (FBARs), each of the FBARs comprising opposed planar electrodes and a layer of piezoelectric material between the electrodes; and

an acoustic decoupler between the FBARs.

2. The band-pass filter of claim 1, in which the acoustic decoupler is structured to provide substantially critical coupling of acoustic energy between the FBARs.

3. The band-pass filter of claim 1, in which the acoustic decoupler comprises a layer of acoustic decoupling material.

4. The band-pass filter of claim 3, in which:

the piezoelectric material has an acoustic impedance; and

the acoustic decoupling material has an acoustic impedance less than the acoustic impedance of the piezoelectric material.

5. The band-pass filter of claim 3, in which:

the piezoelectric material has an acoustic impedance; and

the acoustic decoupling material has an acoustic impedance intermediate between the acoustic impedance of the piezoelectric material and the acoustic impedance of air.

6. The band-pass filter of claim 3, in which the acoustic decoupling material has an acoustic impedance in the range from about 2 Mrayl to about 16 Mrayl.

7. The band-pass filter of claim 3, in which the acoustic decoupling material comprises plastic.

8. The band-pass filter of claim 3, in which the acoustic decoupling material comprises polyimide.

9. The band-pass filter of claim 3, in which the acoustic decoupling material comprises poly(para-xylylene).

10. The band-pass filter of claim 3, in which:

the band-pass filter is characterized by a center frequency; and

the layer of acoustic decoupling material has a nominal thickness equal to an odd integral multiple of one quarter of the wavelength in the acoustic decoupling material of an acoustic wave having a frequency equal to the center frequency.

11. The band-pass filter of claim 10, in which the acoustic decoupling material comprises plastic.

12. The band-pass filter of claim 10, in which the acoustic decoupling material comprises polyimide.

13. The band-pass filter of claim 10, in which the acoustic decoupling material comprises poly(para-xylylene).

14. The band-pass filter of claim 3, in which:

the band-pass filter is characterized by a center frequency; and

the layer of acoustic decoupling material has a nominal thickness equal to one quarter of the wavelength in the acoustic decoupling material of an acoustic wave having a frequency equal to the center frequency.

15. The band-pass filter of claim 1, in which the acoustic decoupler comprises a Bragg structure.

16. The band-pass filter of claim 15, in which the Bragg structure comprises one or more low acoustic impedance Bragg elements interleaved with high acoustic impedance Bragg elements.

17. The band-pass filter of claim 16, in which two of the high acoustic impedance Bragg elements additionally serve as one of the electrodes of each of the FBARs.

18. The band-pass filter of claim 16, in which:

the band-pass filter is characterized by a center frequency; and

each of the Bragg elements comprises a layer having a nominal thickness equal to an odd integral multiple of one quarter of the wavelength in the respective material of an acoustic wave having a frequency equal to the center frequency.

19. The band-pass filter of claim 1, additionally comprising an electrical connection between adjacent ones of the electrodes of the FBARs.

20. The band-pass filter of claim 19, in which the acoustic decoupler is located between the adjacent ones of the electrodes.

21. The band-pass filter of claim 1, additionally comprising a ladder filter electrically connected in series with the stacked pair of FBARs.

22. The band-pass filter of claim 21, in which the ladder filter comprises additional FBARs.

23. The band-pass filter of claim 21, in which:

the band-pass filter additionally comprises an electrical connection between adjacent ones of the electrodes of the stacked pair of FBARs and the ladder filter; and

the remaining ones of the electrodes of the stacked pair of FBARs provide the output terminals of the band-pass filter.

24. A band-pass filter characterized by a center frequency, the band-pass filter comprising:

a stacked pair of film bulk acoustic resonators (FBARs), each of the FBARs comprising opposed planar electrodes and a layer of piezoelectric material between the electrodes, the piezoelectric material having an acoustic impedance; and

between the FBARs, a layer of acoustic decoupling material having a nominal thickness equal to an odd integral multiple of one quarter of the wavelength in the acoustic decoupling material of an acoustic wave having a frequency equal to the center frequency, the acoustic decoupling material having an acoustic impedance less than the acoustic impedance of the piezoelectric material.

25. The band-pass filter of claim 24, in which the acoustic decoupling material comprises one of polyimide and poly(para-xylylene).

26. An electrical filtering method, comprising:

providing a pair of film bulk acoustic resonators (FBARs);

applying an input electrical signal to one of the FBARs;

coupling less acoustic energy between the FBARs than would be coupled by direct contact between the FBARs; and

outputting a filtered output electrical signal from the other of the FBARs.

27. The filtering method of claim 26, in which:

the coupling establishes a first pass bandwidth; and

the method additionally comprises, prior to the applying, filtering the input electrical signal with a second pass bandwidth narrower than the first pass bandwidth.

28. A method of fabricating an acoustically-coupled device, the method comprising:

fabricating a first film bulk acoustic resonator (FBAR);

fabricating an acoustic decoupler on the first FBAR;

fabricating a second FBAR on the acoustic decoupler, including subjecting the acoustic decoupler to a maximum temperature; and

prior to fabricating the second FBAR, baking the first FBAR and the acoustic decoupler at a temperature not lower than the maximum temperature.

29. The method of claim 28, in which the acoustic decoupler comprises a layer of polyimide.

30. The method of claim 29, in which fabricating the acoustic decoupler comprises depositing the layer of polyimide by spin coating.